PROGRESS REPORT NO. 3,

COVERING THE PERIOD

FROM SEPTEMBER 1 TO SEPTEMBER 30, 1963

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[1963] 5p

ON

(NASA CONTRACT NASw-766)

(NASA CR-52522)

Development of Launch Vehicle
Optimization Systems utilizing
the System Optimization and
Review Technique

N 65 81899

NASA CR-52522

UNPUBLISHED PRELIMINARY DATA

LEAR SIEGLER, INC.
Instrument Division

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Grand Rapids 8, Michigan

Task 1: Define a generalized launch system in terms of the interconnected subsystems.

This task, assigned by subcontract to LSI Space Systems Center, was completed during this reporting period.

The launch vehicle defined was a medium thrust, liquid propellant, three-stage launch vehicle capable of inserting an unmanned spacecraft into a near-earth orbit. The launch vehicle, consisting of the three stages and associated GSE, was described in terms of the interconnected subsystems.

The subsystems which comprise the launch vehicle were described at various levels of complexity. A preliminary study of the number and kind of element descriptors that would be required at these complexity levels was conducted.

Task 2: Select a subsystem which is amenable to analysis by F. H. Westervelt's technique. This selection will be subject to approval by the NASA Project Monitor.

This task was completed during a previous reporting period.

Task 3: Collect the data required to define the selected subsystem with Dr. Westervelt's technique.

This task was completed during a previous reporting period.

Task 4: Define the subsystem behavior in terms of such physical parameters and characteristics as cost, reliability, weight, performance, etc.

This task is proceeding satisfactorily.

As previously indicated, Task 4 has been divided into a parallel effort consisting of two parts. Specific progress accomplished on the two parts of this task is as follows:

1. Simulator simulation of the guidance subsystem.

   a. System Definition

      The guidance system has been defined in terms of the interconnected elements which comprise it.

   b. Element Descriptors

      Operational and physical characteristics of the elements have been collected and preliminary development initiated on the element descriptors.

    c. Subroutines

        An iteration subroutine has been programmed.

    d. Source Program

        Development of the source program has been held in abeyance
        pending completion of a., b., and c. above.

2. Independent simulation of the guidance subsystem.

    a. Performance Analysis

        Performance is being measured with an error analysis conducted
        by comparing the flight profile measured by the guidance
        system with a zero-error flight profile. The passive role
        of the guidance system in this analysis provides assurance
        that its performance is separated from control system char-
        acteristics and airframe response. Data should be obtained
        from this analysis during the next reporting period.

    b. Reliability Analysis

        Reliability will be measured by an analysis conducted using
        a systems reliability analysis technique developed by J. S.
        Donaldson (A refined version of this technique was described
        in a paper authored by J. S. Donaldson and F. K. Heiden:
        NASA Reliability Abstracts and Technical Reviews, Serial
        No. 739-1). This analysis is to be initiated during the
        next reporting period.

    c. Cost Analysis

        Initiation of the cost analysis has been suppressed in favor
        of performance and reliability due to the time scale involved
        in Phase I.

Task 5: Refine existing computer techniques and develop new methods as required
to adapt Dr. Westervelt's technique to NASA launch vehicles and pro-
pulsion program problems.

This task, assigned by subcontract to the University of Michigan,
is proceeding satisfactorily.

As previously indicated, Task 5 is divided into four parts. Specific
progress accomplished on the four parts of this task is as follows:

1. Simulator

    Programming on the simulation technique is continuing. Completion

of the programming and initial checkout is now expected to
begin in, late November.

2. Stepwise Regression With Simple Learning

Programming and initial checkout of the regression program is
complete. During the next reporting period this program will
be used to determine the performance predicting equation with
data obtained from the independent performance analysis of Task 4.

3. Optimization

Programming on the optimization technique is proceeding satis-
factorily. It is expected that one additional month will be re-
. quired to complete the programming and begin initial checkout.

4. Nonlinear Estimation

Programming on the nonlinear estimation technique was initiated
during this reporting period. Completion of the program is not
expected during Phase I.

Task 6: Process the available data and establish the areas of strength and
weaknesses in order to extend the technique for eventual analysis
of the entire launch vehicle complex.

The status of tasks I through 5 is such that work on this task will
be initiated during the next reporting period.

<u>NASA LVO-SORT SEPTEMBER PROGRESS REPORT</u>

An oral presentation covering cumulative technical progress through September on LVO-SORT Contract NASw-766 was made on 3 October at NASA Headquarters in Washington, D. C. The attendees at this presentation were as follows:

<u>NASA</u>

Dr. R. B. Morrison
Mr. A. Nelson
Mr. J. Salmonson
Mr. J. McGolrick
Mr. W. Bos

<u>Contractor</u>

<u>LSI-Instrument Division</u>

Mr. J. S. Donaldson
Mr. W. E. Miles
Mr. H. Norder

<u>LSI-Space Systems Center</u>

Mr. R. D. Green

<u>University of Michigan</u>

Dr. F. H. Westervelt

The technical effort required to achieve Phase I objectives is divided into three essentially autonomous parts with each member of the LSI-ID/LSI-SSC/UofM contractor team having principal responsibility for one of these parts. The three parts and responsibilities are as follows:

1. Development of simulator and associated analytical techniques. University of Michigan.

2. Basic study of applicability of the simulator to the NASA-LVO problem. LSI-Instrument Division.

3. Preliminary definition of representative launch vehicle complex. LSI-Space Systems Center

The technical presentation followed this functional division and provided details and documentation pertaining to Phase I progress as reported in this and previous reports.

During this reporting period work was conducted on Tasks 1, 4, 5 and 6 delineated in the contract statement of work. A brief report of work accomplished against the contractual tasks follows: